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instance, in the Pearl River and Yangtze River, where 60-70% of the freshwater areas in China occurs, fish feed and grow all year long.

After 1949, the Chinese government instituted radical reform. Fishermen were given their own fish ponds and culturing tools, many forms of government assistance were made available, and communes were developed to further enhance fish production. As a result, freshwater fish production increased from 50,000 tons in 1949 to 1,000,000 tons in 1959.

The first requirement for this expanding fish culture is the production of fish fry and fingerlings. New techniques have been successful in developing large scale artificial hatching, utilizing naturally occurring fry, culturing of species and improving survival rates of cat. and other fish species. In addition, improvements have been made in fish food production, elimination of fish diseases and enemies, and harvesting of adult fish.

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CHINESE FISH CULTURE

INTRODUCTION

The production of fisheries depends upon the utilization of commercial species from both salt water and fresh water. The major components of fisheries are ocean fisheries and inland fisheries. In the latter category are two great sources: the naturally occurring species such as fish, shellfish, algae, etc., and the artificially reared species.

China is among the leading nations with the largest fresh-water areas. Her rivers, lakes, ponds, and reservoirs are extensive everywhere and aggregate more than 45 million acres. Fully one-third of this acreage has, at present, the necessary conditions for fish culturing. In addition, there are seven or eight million acres of rice fields, in which some supplemental fish culturing can be conducted. With further hydroelectric development, more and more reservoirs and canals will be created, which will add to the potential of fish culturing areas.

Most of the Chinese territory is situated in temperate and subtropical zones. This affords a suitable water temperature and a long growing season for fishes. In the Pearl River and Yangtze River, for instance, fish feed and grow all year round. From 60 - 70% of freshwater areas in China are associated with the above two river systems. Also, the principal freshwater areas are distributed on the plains

and close to farms and towns. They receive a large amount of waste disposal and are therefore highly fertile. Ample fish food is present resulting in fast growth of the fishes. Besides the various highly valued species of freshwater fishes that are produced in the various bodies of freshwater, there are also anadromous species that are available at river mouths. There are therefore a variety of fish species that can be cultured locally, from South to North, and from the seacoast to the interior. In short, the resources of freshwater fish culture in China is extremely rich, and the ecological conditions are very favorable indeed.

China has a long and an excellent tradition in freshwater fish culture. She is the first nation in the world that practiced pond fish culture. Record of fish culture goes as far back as 11th century B.C. At that time, carp raising in ponds had gradually become a regular production. Twenty-four hundred years ago, Fan Li published his Fish Culture Classic, which is the oldest reference in fish culture literature. The Chinese people, known for their industry the world over, have long recognized the economic importance of fish culture, and have regarded fish rearing and bamboo raising as equally highly profitable ventures. A Chinese proverb goes like this: "Depend on the mountain for food when living by the mountain; depend on the water for food when living by the water." The people even created new aquatic habitat to rear

fish, much as farmers cultivate their land to plant crops. Through the centuries, rich experience has been accumulated in the entire fish culture procedure: from fry production, breeding, species selection, utilization of different bodies of water, feed, fertilization, to harvest of adult fish, processing, and storage.

The rich natural resources, the long historic tradition, and the ample experience gained through mass participation are doubtlessly important ingredients for the development of fish culturing industry. But, under the old sociological structure, these ingredients did not do much good, for development of fishing industry was impeded by severe restrictive measures of feudalistic powers from within, and by invasion of imperialistic powers from without. Lakes, ponds, and streams were in the hands of landlords, who imposed heavy fees for leasing. In a certain small village in Chekiang Province, the number of landlords was 10.7% of the village's population, but these landlords owned 40% of all fish ponds in the village. Sixty-nine percent of the people were tenant farmers who owned a combined total of 22% of the ponds. These farmers had to lease ponds to raise fish, and they had to pay heavy rentals to the landlords at the one hand and heavy taxes to the government on the other hand.

FISH PRODUCTION

Taking the nation as a whole, the highest production year of freshwater fishery products was in 1936, when 500,000

tons were recorded. In 1949, the annual production had dropped to 150,000 tons. Since then, like all other industries in the country, fisheries production started to climb upwards. After going through three years of the restoration phase in the national economy and the first 5-year plan, fisheries have entered a new developing era. New achievements were reached especially after 1958.

During the first few years after 1949, the Chinese government instituted radical land reform. All fishermen were given their own fish ponds, and were given culturing tools. In addition, many other forms of government assistance were given. Large amounts of financial support were given to fishermen in the form of fishery loans and subsidies; taxes on freshwater fish culturing and sales taxes on fish fry were exempted; salt was rationed according to needs; rail charges for transportation of fish fry were lowered; fishery cooperatives were established at fishing centers. All these have effectively helped restore and develop the production of fish culture. Freshwater fish culture has suddenly entered into a new phase and has been making rapid progress. To further enhance production, fishery cooperatives were amalgamated into a nationwide venture. During the great, widespread movement of cooperatives in all the farm villages in the entire nation, many fishery ventures either participated in the major agricultural cooperatives or formed their own large fishery

cooperatives. In 1956, this cooperative movement in our vast freshwater fish culture industry had accomplished a solid foundation.

People's communes were developed in 1958, and in a few short months, became widespread in all farm villages. So much emphasis was placed on the development of the fishing industry that fishing was included as one of the production items of the communes, and freshwater fish culture was regarded as an important source of fish production. Under large scale operation of the communes, it was possible to solve the traditional knotty question of regional limit of the old cooperatives and to launch into an orderly overall planning and arrangement in manpower, material, and money. Many fish culturing ventures that were impossible to develop before became now feasible; some lakes and reservoirs were now utilized by the people in the communes to raise fish. Consequently, the scale of fish culture was greatly expanded in rapid succession and fish production made continuing strides over the years.

Based on actual conditions China adopted the principle of simultaneous emphasis on rearing and catching. Whether to emphasize more than one or the other depended upon the time, locality, and natural environment. For instance, in areas neighboring the ocean or the big rivers and lakes, catching shall be emphasized more than rearing. In regions where

there are ponds, reservoirs, creeks, and shallow shelf zones on the sea coast, rearing shall be emphasized more than catching. In localities where both of the above conditions prevail, equal emphasis is placed on rearing and catching. This is vastly different from other nations in the world, where 90% of fish production come from catching and only 10% from rearing. Under our principle of parallel emphasis on catching and rearing, freshwater fish culture has been very successful. In 1949, the production from freshwater culture was estimated at around 50,000 tons. In 1959, the production surpassed 1,000,000 tons. This is evidence of the correctness of the doctrine of equal emphasis on catching and rearing, and of the great production potential in Chinese freshwater fish culture.

DEVELOPMENT OF RESOURCES

Freshwater areas in China are distributed widely in farm villages, making it extremely convenient for the farmers to engage in fish culturing business. This was aided tremendously by the formation of communes, whereby money, material, labor, and brains were concentrated to make fast and good results possible. In many areas, the people mobilized themselves in building fish ponds, and participated in a large scale in all phases from fry planting to harvest. Due to the mass participation by the public, freshwater fish culture has become so widespread, so economical, so efficient,

and so productive that today 95% of freshwater fish culture production come from the communes.

In the last decade, federal fish hatcheries have also undergone rapid development. New hatcheries were installed; small ones were enlarged. By 1957, there were already 280 hatcheries; by 1959, this number had jumped to nearly a thousand. The federal hatcheries served as demonstration and extension centers. They provided to the public fish eggs and fry, taught people new techniques, demonstrated new tools and methods. This leadership of the federal hatcheries, plus the mass participation by the public are the essential ingredients for the unprecedented development in Chinese freshwater fish culture.

China was not always blessed with a solid footing in freshwater fish culture. In the past, the utilization rate of all freshwater areas was only 2-3%, and the average yield was less than 10.00 kg/ha. It was therefore apparent that the great potential in developing Chinese freshwater fish culture lay in the expansion of fish culturing areas and in the increase of per unit area yield. By adhering to the above two efforts over the years, great strides have been made in our freshwater culture business.

The fish culture area was increased from 300,000 ha by 1954, to 1,000,000 ha by 1957. The rate of expansion was especially accelerated in 1958, to 3,000,000 ha in 1959.

This increase surpassed the summed increase of the preceding 5 years by 1.3 times. After this great expansion, fish rearing waters were no longer confined to ponds and creeks, but were expanded to lakes and reservoirs of several thousand ha in size, to rice fields in many areas, and to the hitherto unutilized storage reservoirs and waste disposal ponds. Fish culturing areas were no longer limited to the few selected locals in the several provinces along the lower Yangtze River and Pearl River valleys, but have spread to the northeastern, northwestern, and southwestern provinces where there had been only a minor scale of fish culturing before and to mountainous and far interior areas such as Sinkiang and Tsinghai Provinces, where no fish culture had ever been practiced. In fact, freshwater fish culture has spread into the entire country and the nation has attained the goal of "a country of fish and rice."

The yield per unit area also improved greatly. In 1952, the highest yield was recorded by Wsi Ah-tuh of Sungtse Village, Wusi, Kiangsu, whose pond produced 5,500 kg/ha. In 1957, the yield advanced to 15,000 kg/ha in a pond at Tsoukwian District, Kwangtung Province. During the year of 1958, a pond owned by Tai Hu Commune in Wusi District, Kiangsu, produced a record yield 32,500 kg/ha. In the same year, high yields were reported from many large culturing areas. The improvement in per unit area production occurred all over the nation and in all kinds of waters: ponds, lakes, reservoirs, or rice fields.

PRODUCTION OF FISH FRY AND FINGERLINGS

The first requirement for rapidly expanding fish culture is the production of fish fry and fingerlings. Without the capability of producing large stocks of fish fry, it is fruitless to expand culturing areas. To solve the large scale fry production problem, special emphasis was placed on the principle of "local raising, local breeding, and local rearing." Four lines of attack were launched: large scale artificial hatching, utilization of naturally occurring fry, culturing of species, and improving survival rate. Firstly, the program that was most responsible for the massive increase of fry production was the large scale operation of hatcheries. At present, artificial hatching of fish eggs has spread all over the country and has had huge success with new techniques. In breeding the common carps (Cyprinus carpio), for instance, it is now possible to induce the carp spawn during autumn and winter, thereby eliminating the season limiting factor in carp spawning and opening a new door to year-round hatching operation. Much research has been done heretofore both at home and abroad on how to bring the silver carp (Hypophthalmichthys molitrix) and the white big head (Aristichthys nobilis) to spawn in ponds but without any success. In 1958, fishery biologists in Kwangtung and Chekiang succeeded in making these two species spawn in the pond by a method that combined external conditions and

internal sex-stimulating factors. The method was based on the fact that breeding activity of fishes is controlled by the central nervous system, which, in turn, is affected by environmental factors.

Many new fry collection stations have been established in many provinces from as far north as Heilungkiang to as far south as Hainan Island. New kinds of seine nets have been devised and fry production has been increased by several fold.

Cultured fishes are no longer confined to the four "domesticated" white amur or species of grass carp (Ctenopharyngodon piceus), silver carp (Hypophthalmichthys molitrix), and white bighead carp (Aristichthys nobilis), but now include more than a dozen species. Even the so-called "harmful" predacious species such as the snakehead (Ophiocaracanthus argus), Chinese perch (Siniperca chuatsi), etc. have been turned into beneficial species by separate rearing.

Fish fry production has also been increasing the survival of the young fish. Through predator control, density control, feed selection, and disease prevention, the survival rate from fry to fingerlings in China was increased by 34.7% in 1957 over 1956 and increased by another 35.1%, in 1958. In 1959, the nation's total fry production reached 128,500,000,000, which surpassed 1957 by 4.5 times. Fingerling production reached 23,300,000,000 fish, an increase on 3.8 times during the same period.

FISH FOOD PRODUCTION

Fish food is the material foundation for rapidly developing fish culture production. In attacking the fish food problem, we found a method which derives the food from the water, and depends heavily on aquatic vegetation and green fertilizer. Through skillful cultivation of several selected kinds of water plants such as the duckweed, water lily, etc., considerable quantity of vegetable food was produced. The success of green fertilizer came from a proper mixture of materials that were put into the composer. Much progress was made in enlarging food producing areas, in finding new varieties of aquatic plants that were fit as fish food, in searching for substitutes, and in improving feeding techniques. In some localities preliminary success was achieved by adding various antibiotics to fish foods to enhance the growth rate of the fish. This opened a new approach to the solution of the fish food problem.

ELIMINATION OF FISH DISEASES AND ENEMIES

Eliminating fish diseases and enemies is another important step to improve fish culture. Under the general principle of total prevention and positive care, many simple devices were found that effectively controlled fish diseases. In preventive work, fish ponds, fish seeds, and fish foods were sterilized. In control work, the causative agents and their life history of several major diseases among our cultured fish were well known and effective chemicals were available.

In short, today we are able to control most fish diseases and enemies within the entire nation and have increased the survival rate of cultured fish, and have made great strides in the development of fish culture.

HARVEST OF ADULT FISH

The final step in developing fish culture is in the harvest of adult fish. The objectives of fish production cannot be fulfilled until all three phases of seeding, rearing, and harvesting are accomplished. Experience in the last decade led us to realize that in order to increase the harvest it was essential to modernize the fishing gear. Concrete results were obtained in the last regard. In many fish culturing areas, various kinds of deep water nets were devised for large scale operation, thereby increasing the catching rate of bottom fishes. Meanwhile, fishing techniques were improved, based on the principle of combined "luring, chasing, and encircling." Although the harvest of adult fish was greatly increased due to the use of new fishing gear and the improvement of fishing techniques, it still required too much labor. Since 1959, research has been emphasizing mechanization or semi-mechanization of fishing operation in order to save human labor. Fundamental reconstruction in altering water bodies is another essential condition for the high development of fish culture. Valuable experience in altering water bodies was obtained from the many various

types of water bodies and the different methods of their utilization. After studying the data collected from many culturing areas, we adopted the basic method of "five changes" for fish ponds, based on the central principle of changing from shallow to deep. These five changes were: deepen shallow ponds, combine small ponds into large ponds, seal leaking ponds, circulate flow in dead ponds, and convert lakes into fish ponds. By so doing, fish culturing acreage was greatly increased and the production potential of fish ponds was fully developed. The main objectives in altering large water masses are to prevent escape rate and to increase survival rate, growth rate, and catch rate, with emphasis placed on prevention of escape and on increase of catch. China has created the all-bamboo fish weir which can extend to 40 meters deep. By the combined use of metal wire and wood,

she has produced metal weir that extend to 160 meters deep. Movable floating doors are perhaps the most complex structures in a fish weir. After many improvements, we can now make these doors which can freely move and will prevent fish from escaping. Another valuable experience that has been accumulated concerns the reconditioning of fish ponds. Through reconditioning work, favorable conditions for fish rearing are created, making available many new water bodies suitable for fish culture purpose, including those which were regarded heretofore as unusable as fish ponds.

To raise the per-unit-area production is a very important phase in developing fish culture. The high production figure per unit area was obtained only through experience by capitalizing on the solution of the problems discussed above. In recent years, especially in the Great Leap Forward year of 1958, the people through their actual experience have achieved high producing methods in small water bodies. These methods were based on eight ingredients: water, seed, food, density, mixing, rotating, prevention, and control. These have become the model fish culturing techniques and have been extended for general practice throughout the country. Through these methods, the per-unit-area production in fish ponds has greatly increased. In some areas, high production was also achieved in large bodies of water. This was a very important contribution to the production leap of our country and has a significant effect on the world's fish culturing technique.

Accompanying the increase production, vast experience was obtained, and much needed scientific technique was added to the reservoir of fish culture knowledge.